SOIL CONSERVATION

CLAUDE R. WICKARD
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. VI • NO. 3 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON SEPT. • 1940

CRESTED WHEATGRASS IN COMPETITION WITH THE NATIVE GRASSLAND DOMINANTS OF THE NORTHERN GREAT PLAINS

By B. W. ALLRED [1]

THERE appears to be a general agreement among authorities that crested wheatgrass (*Agropyron cristatum*) is the most versatile grass used in the revegetation of abandoned farm lands in the Northern Great Plains. The adaptability of this grass is borne out by a mass of experimental and observational data accumulated in 42 years on the dry-land experiment stations and private farms and ranches of the Northern Great Plains. Most of the information relative to the value of this grass has been obtained since 1920.

Old established stands have lasted through the disruptive, single or compound influences of drought and insect depredations, with no significant losses. Thousands of acres of new and thriving stands of the grass, outnumbering many times the acres planted to other grasses, have been grown in the last decade. Crested wheatgrass is now the undisputed champion of all grass species planted in the Northern Great Plains for the purpose of reclaiming barren cast-off farm lands. The Soil Conservation Service alone has established over 150,000 acres of crested wheatgrass in the last 5 years and many thousand acres more have been established by other Federal agencies, farmers and stockmen.

During the 42 years since crested wheatgrass was first introduced to the Northern Great Plains, placed under experimentation and finally put to practical use, there have accumulated many criteria regarding its limitations and productivity on abandoned farm lands. There is, nevertheless, much yet to be learned about it and its potential ecological niche in the Northern Great Plains. One of the greatest, most important and universal questions concerns its propensities for migrating into and replacing the native grassland dominants. This highly mooted question has ardent supporters on each side. The substance of such debate is based on more than whimsical tendencies for callow argument, for, if the major replacement of the great climax grasslands is threatened by this more productive foreign invader, such a plant revolution would portend highly implicative adjustments in the grass-livestock equation. Some of the significant factors bearing on this point are mentioned in this discussion.

Crested wheatgrass was introduced to the United States by the Department of Agriculture in 1898 through the efforts of N. E. Hansen of the South Dakota Agricultural College, while he was engaged in plant exploration work for the Department in Russia and Siberia. The grass is native to the rigorous, cold, dry climate of the steppes of Eurasia. In the Northern Great Plains it found a habitat quite like its homeland in Eurasia and, consequently, few naturalization processes were necessary.

From its introduction in 1898 until 1915, crested wheatgrass was tested in minor plots over much of the West, but it was given lukewarm attention and led a neglected or orphaned existence. In fact, no record is available as to the outcome of the plantings made from the 1898 seed importations. Present records indicate that all of the crested wheatgrass now growing in the United States originated from seed importations dating 1906 or later.

[1] Chief range conservation division, Soil Conservation Service, Northern Great Plains Region, Lincoln, Nebr.

The species began drawing the interest of western agrostologists contemporaneously with the 1915 plantings at Mandan, N. Dak., Moccasin, Mont., and the University of Saskatchewan in Canada. By 1930 it had been tried at most experiment stations in the Northern Great Plains of the United States and Western Canada, and plant breeders had done much to qualify it for the important role it is to play in helping reclaim the forsaken farm lands left to be preyed on by erosion during the parlous decade of 1930 to 1940. During that period thousands of acres of these lands in the Northwestern United States have been seeded to crested wheatgrass by various Federal, State, and private agencies. Similar seedings have been made by the Dominion Government in Canada on thousands of acres of eroding abandoned fields and now many of these areas have been converted into productive communal pastures for the livestock of remaining farmers and stockmen.

A Significant Role

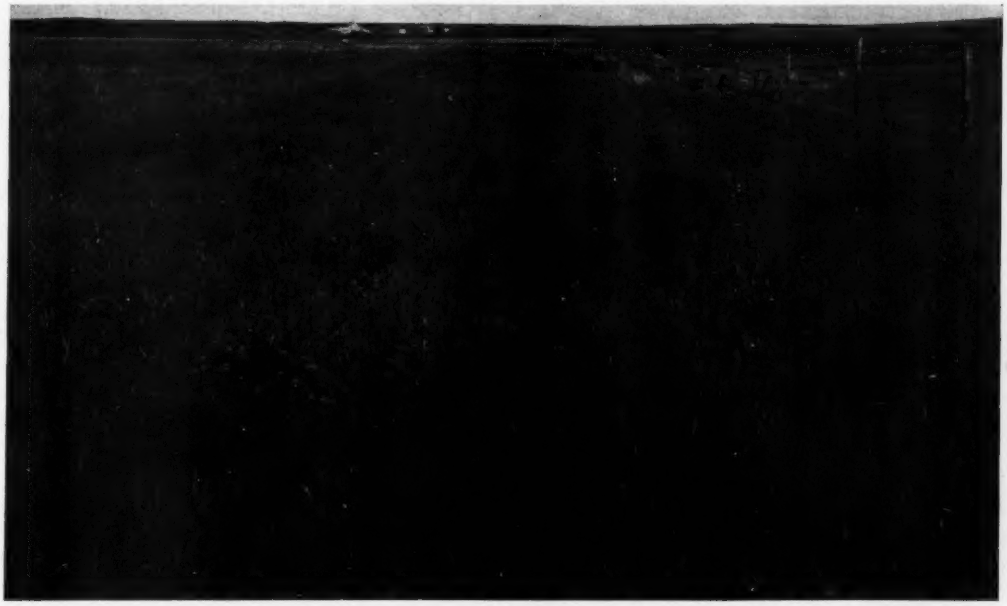
The following discussion is a compendium of facts pointing out the significant role ascribed to crested wheatgrass in the economy of the Northern Great Plains.

1. Crested wheatgrass had undergone sufficient experimentation and field testing by 1930 to prove its value as a forage plant in the Northern Great Plains and Western Canada. This occurred at a propitious time, for with the simultaneous occurrence of the great economic upheaval and drought of the decade, 1930 to 1940, approximately 25,000,000 acres of former wheat and feed cropland in Western United States was abandoned. These neglected lands were left to the caprice of erosion and with no ready sponsor to flout the elements that were conniving against their proper use. Immediately, there was needed for these lands a quick-growing perennial forage plant capable of producing abundant viable seed and hardy seedlings and mature plants with the hardihood to withstand weed competition, drought, insect depredations and other rigors of the Great Plains habitat. Crested wheatgrass does not have all these qualities to perfection, but it comes nearer having them than any other grasses used. Some plantings have failed entirely but many others have been successful, and there are now thousands of acres of vigorous stands that are producing both seed and forage.

2. Crested wheatgrass thrives in the cool temperatures of the Northern Great Plains and no winter killing is recorded from even as far north as the Canadian Provinces. Its winter hardiness is attributable to the fact that it is derived from the circumpolar genus *Agropyron* and is the Eurasian ecological equivalent of the blustem wheatgrass (*Agropyron smithii*) of the Great Plains, with which it also has a close botanical relationship. It is northerly in derivation and consequently has early spring growing habits. The dry-land sedges, common to the Northern Great Plains, notably *Carex filifolia*, *Carex heliophylla*, *Carex stenophylla* and other grass-like forage plants related to this group, green up at approximately the same time as crested wheatgrass. It usually begins to grow during the last few days in March or the first 10 days in April, depending on seasonal and site variations. The grass species that have somewhat parallel growth periods with crested wheatgrass are junegrass (*Koeleria cristata*), and Sandberg bluegrass (*Poa secunda*). They start growth at about the same time, but the two native grasses mature about 2 to 3 weeks earlier than crested wheatgrass. The latter starts about a week to 10 days ahead of bluestem wheatgrass and needle-and-thread grass (*Stipa comata*), the codominant mid-grasses of the climax grassland formation. Blue grama (*Bouteloua gracilis*) and Buffalo grass (*Buchloe dactyloides*), two of the short-grass components of the Great Plains climax, begin spring growth from 3 weeks to 6 weeks later than crested wheatgrass.

The early spring growing tendencies of crested wheatgrass give it economic significance in the part it plays in the grazing management of the grasslands. As previously stated, the dry-land sedges have vernal tendencies equal to crested wheatgrass. They are also highly nutritious but do not occur extensively enough to supply the demand for early spring forage. Junegrass seldom ranks importantly enough on ranges to contribute satisfactory yields of forage, and Sandberg bluegrass fluctuates so radically with the vagaries of weather that it is undependable and is not of much importance in forage types that are properly managed. Bluestem wheatgrass and needle-and-thread grass furnish excellent amounts of early forage when ranges are properly managed, but too often the ranges are grazed to the point where these mid-grasses are forced out to the advantage of the short grasses which persist under greater stresses of grazing than the mid-grasses.

3. Crested wheatgrass in its present role has filled two significant gaps: First, it has occupied and given protection to wasting farm land and, second, it is fitting ideally into a needed pasture rotation program by supplying an abundance of early forage which the native midgrasses are frequently not supplying because



This is a June 1939 view of a crested wheatgrass field which was planted in saltgrass in September 1938. The crested wheatgrass has developed a thrifty stand and is heading out.

they have been either eliminated or their vigor has been impaired.

4. Crested wheatgrass adapts itself to varying soil types. It is known to thrive on glacial sands and sandy loams at Huron, S. Dak.; on the Pierre soils of Winner, Ardmore, Belle Fourche, and Pierre, S. Dak.; and on the gravel soils of Fort Collins, Colo., and Judith Basin, Mont. It produced a vigorous stand on raw Tertiary shales used in the earth fill of a stock pond at Lander, Wyo., where it was planted to replace riprap on the upstream side of the fill. It has served admirably for this purpose.

5. Crested wheatgrass ranks equal to, or better than, smooth brome (*Bromus inermis*) and slender wheatgrass (*Agropyron pauciflorum*) in chemical composition and generally outyields both in hay production in the drier plains where rainfall is between 12 to 17 inches.

6. Crested wheatgrass is a prolific seed producer with yields varying from a few pounds in dry years to 700 pounds per acre in exceptionally good years. It has been known to yield as high as 1,400 pounds per acre on subirrigated lands at Bozeman, Mont. Most commercial productions average less than 300 pounds per acre. In this regard, it is superior to other common species. The seed is easily harvested and threshed with ordinary farm equipment.

7. Crested wheatgrass has a most efficient root system and outyields native and exotic grasses in root production. Its production of roots is double that of slender wheatgrass in both weight and depth of the main root mass. These are admirable qualities in the Northern Great Plains where efficient water-using and soil-binding plants are necessary. It develops a wide-spreading root system which occupies both topsoils and subsoils. The roots in the topsoils spread uniformly in all directions from the crown. This characteristic root growth habit, combined with its early growth, makes for a most impregnable defense against weed competition.

8. Crested wheatgrass is quite resistant to stem rust and ergot and particularly excels slender wheatgrass in this respect.

9. Crested wheatgrass requires little seedbed preparation, the main requisite being a firm seedbed which is often optimum in undisturbed stubble or weed fields.

10. Comparative grazing studies made in the Northern Great Plains on crested wheatgrass pastures and native grasslands have shown that the crested wheatgrass pastures have from 80- to 100-percent greater grazing capacity than native grasslands. However, much more intensive and broader investigations are necessary before definite long-time comparisons can be made. While a trial balance at present shows a preponderance of evidence for crested wheatgrass on the credit side, there are many factors that have to

250840—40——2

be leveled out by diligent and extended experiments.

Crested wheatgrass has no doubt benefited from the stimulus of cultivation exerted in the process of its own establishment as well as those previous cultivations while the land was in other crops. The ultimate effect on grazing capacity at the time when the grass reaches root and stand stagnation common to native grasses is not known. Because the grass is naturally a heavy feeder on moisture and nutrients, there are many who are fearful that the plant's own greediness may bring about its early demise from consequential exhaustion of soil moisture and plant food. The extremes of these grave doubts are probably unwarranted, but it can logically be expected that the big yields common to the first few years of growth may decrease. Certainly the plant growth will always have to be in harmony with its moisture relations. It maintains this harmony because of its well-developed tendency to establish itself in a state of premature dormancy during drought. When moisture is made available, crested wheatgrass revives and quickly begins growing. The fact that thousands of acres have been established during drought years speaks unerringly for its drought-resistant qualities. Furthermore, the possibility of soil exhaustion appears far fetched since the plant is known to exist in stands that are over 25 years old in the Northern Great Plains where there is no present indication of soil nutrient exhaustion. The very fact that it is a dominant in the grasslands of the Eurasian steppes nullifies any general notion that it is destructive of soil resources.

11. Crested wheatgrass probably is not as tolerant of alkaline soils as bluestem wheatgrass but it does successfully grow on soils that are moderately alkaline, as will later be pointed out.

12. Crested wheatgrass bunches enlarge both by tillering and by new shoots originating from short lateral rhizomes. As plants mature they develop a distinctly clumpy habit, leaving the interestices of open ground exposed to erosion. Particularly on high erodible soils, it is desirable to plant with it some of the more aggressive sod-formers such as smooth brome or bluestem wheatgrass.

13. Creasted wheatgrass becomes tough and unpalatable about June 15 when blue grama and buffalo grass are usually in prime grazing condition. Later when the short grasses mature in early September, crested wheatgrass is producing a palatable succulent leaf and stem for late fall grazing. Its early and late season growth habits make it a valuable asset to the livestock industry.

14. A sheepman near Billings, Mont., lambed his herd of 2,000 ewes during the spring of 1940 on a 320-acre field of crested wheatgrass near Winnett, Mont. When the actual use of this half-section is reduced to standard grazing terminology it has an equivalent of 50 animal units for an 8-month period. The sheep were moved from the grass by May 1. A June 1 inspection was made and the grass had recovered from spring grazing and was beginning to head out. It is estimated that the field will yield approximately 150 pounds of seed per acre this year. The superior production obtained on this field can be attributed largely to the superabundance of rainfall that has fallen in the area to date. The grass could not be expected to repeat this excellent performance under the average rainfall conditions of the Northern Great Plains.

An Invader of Native Grasslands

The foregoing statements indicate that crested wheatgrass ranks far ahead of the native grasses in many categories. Therefore, if such a plant revolution as the theoretical extinguishment of the native grasslands by crested wheatgrass were to take place, the losses occasioned by this exchange would doubtlessly be more than offset by the gains. Even if the superior advantages maintained for crested wheatgrass hold forth continuously and make a broad exchange of native climax grasslands for crested wheatgrass lands desirable, there are some extremely dynamic factors that would prevent such a development. There appears little likelihood that crested wheatgrass will usurp the place of native climax grasses because the natives are the true expression, in reality the end product, of the Northern Great Plains climate. They are inured to the peculiarities of this climate and are dominated by it as crested wheatgrass is dominated by the peculiar, but somewhat similar, climate of Eurasia.

The dominants of the Great Plains climax are the two mid-grasses, needle-and-thread grass and bluestem wheatgrass; and the three short grasses, blue grama, buffalo grass and threadleaf sedge (*Carex filifolia*), the latter being a sedge which is the ecological equivalent of a short grass. This group of grasses has a remarkable versatility for supplying the needs of livestock when they are maintained in proper balance. Threadleaf sedge provides the earliest spring grazing and is closely followed by the two mid-grasses and later by the two short grasses which green up in June and supply green feed most of the summer, except in drought years. Needle-and-thread grass has fall growing hab-

its like crested wheatgrass and provides green feed late in autumn when rainfall is adequate.

Although such cases have been reported, I have never seen a situation where crested wheatgrass has migrated into a climax stand of grasses or even produced competitive stands when it has been drilled in them. However, it has been known to grow or migrate into abandoned farm lands or on the bare areas in native grasslands caused by drought or other causes. My own observations and studies include only the region of the Northern Great Plains and its extension into western Canada.

The vast seedings of crested wheatgrass in the Northern Great Plains and the Prairie Provinces of Canada, made in the past 20 years, offer a most fertile field of observation. The native bluestem wheatgrass has, in many instances, made partial or complete encroachments on abandoned farm lands. Invariably, where bluestem wheatgrass has taken over, the crested wheatgrass has failed to make stands. Yet, repeated observations have shown that crested wheatgrass was outyielding bluestem wheatgrass from 60 to 100 percent in dry matter in the adjacent stands. Conversely, the native grasses have been slow to migrate into stands of crested wheatgrass although instances have been noted at Miles City, Mont., and at Swift Current, Canada, where traces of blue grama in rare instances, and considerable amounts of bluestem wheatgrass are moving into older stands of crested wheatgrass.

Crested wheatgrass originating on a pasture at Ardmore, S. Dak., has migrated 1,000 feet in 7 years on to abandoned farm land, according to V. I. Clark, acting superintendent of the Ardmore field station.

Crested wheatgrass seedings in 1938 on the native sod of the golf courses at both Roundup and Lewistown, Mont., failed. The 2 years following these plantings were highly favorable to the growth of the grass and even though the plantings were made in both fairway and rough, all failed.

Rather phenomenal results were obtained from crested wheatgrass planted on the Culbertson soil conservation project in Montana in September 1938. It was drilled into a 25-percent stand of saltgrass (*Distichlis stricta*) along the headland of a cultivated field. The results of this planting are noteworthy in that a thrifty stand of the grass had developed and seeded out by June 12 of the following year.

This may appear paradoxical in light of some previous statements made in this paper; however, there are pertinent ecological factors that can be applied to explain the situation. One is that saltgrass is not a climatic dominant in the Great Plains habitat, but is a member of a developmental community in the plant succession of the area. Next, this particular site is in a slightly subirrigated and alkaline bottomland where the saltgrass has gained prominence because the local dominant, bluestem wheatgrass, has been eliminated by grazing. A pure stand of the latter is found in an adjacent ungrazed lot. Crested wheatgrass has a close ecological and botanical relationship to bluestem wheatgrass, and hence it seems logical to assume that in this case it is merely usurping the natural role of bluestem wheatgrass in supplying a mid-grass that is common in the climax. On this particular site, saltgrass, which is likewise a short grass, has benefited by the past grazing practices which have largely eliminated bluestem wheatgrass.

By a similar deduction, it can be readily presumed that crested wheatgrass will migrate to some extent into the short grasses once the native mid-grasses have been removed by biotic influences. These migrations will no doubt be limited to sites with naturally greater moisture equivalents, such as flood plains, swales, and ranges where the short-grass stands have been seriously reduced by various causes. Reports from men at some of the Northern Great Plains experiment stations have verified this conclusion.

General Conclusions

Crested wheatgrass appears to possess more of the superior and fewer of the undesirable qualities than the other species used in reclaiming abandoned farm lands.

Present information indicates that it does not invade and dominate the climax grasslands. It has migrated successfully into disturbance or successional communities of annual weeds. So far it has failed to produce competitive stands when drilled into established stands of bluestem wheatgrass. Crested wheatgrass has made only minor migrations into open stands of blue grama.

Bibliography

Clements, Frederic E.: Nature and Structure of the Climax. 1936.

Kirk, L. E., T. M. Stevenson and S. E. Clark: Crested Wheat grass. 1934.

McQuilkin, W. E.: Résumé of Information on Crested Wheatgrass for the Northern Great Plains. 1936.

Westover, H. L., J. T. Sarvis, LeRoy Moomaw, George W. Morgan, John C. Thysell and M. A. Bell: Crested Wheatgrass as Compared with Bromegrass, Slender Wheatgrass, and Other Hay and Pasture Crops for the Northern Great Plains. 1932.

Senate Document 99. 1936.

A RANGE CONSERVATION DEMONSTRATION IN THE LAND OF THE NAVAJOS

By HUGH G. CALKINS [1] and D. S. HUBBELL [2]

THERE have now been 7 years of soil conservation research and demonstration by the Navajo Experiment Station at Mexican Springs, N. Mex. This station was one of the first to be organized under the national emergency conservation program. It has been the scene of many varied and significant research and demonstration projects relating to livestock, range management and farming in the Southwest.

Grazing of livestock is the dominant industry on the Navajo Reservation and throughout the Southwest, and therefore presents the most pressing land-use problems. Demonstration of proper grazing and management practices, together with the use of improved livestock is important to the Navajo Reservation livestock program and to Service planning and operations in Region 8.

The research program, which is of particular significance in the long run, is still in the midst of studies which will require more time for completion.

BOULDER DAM, it is said, was partly responsible for establishing the station at Mexican Springs. A large proportion of the silt pouring in behind this costly structure was traced to the San Juan drainage, much of which lies within the Navajo Reservation.

When this siltation, together with the rapid rate at which erosion was destroying Navajo ranges, was brought to the attention of John Collier, Commissioner of Indian Affairs, early in 1933, he asked for an investigation of erosion conditions on the Navajo Reservation.

H. H. Bennett, W. C. Lowdermilk, C. K. Cooperrider, C. E. Ramser, and others undertook to make that investigation. A site was picked where erosion and erosion-control methods might be studied. With permission of the Navajo Tribal Council an agreement was drawn up July 14, 1933, under which was established the Navajo Experiment Station. A few months later, with the creation of the Soil Erosion Service, Mexican Springs was transferred to the new agency as its first official experiment station.

A SMALL but almost complete watershed, typical of the Navajo country, the 60,000-acre area under study ranges from an elevation of 8,120 feet on the high western watershed divide to 6,200 feet in the lower eastern portions. Average annual rainfall records are available only since 1934. They show precipitation in the lower portions of 7.5 inches; in the upper reaches, 18 inches.

Owing to the preponderance of foothill and mountain topography, shallow residual soils, and deeply filled alluvial valleys, the area is susceptible to severe, accelerated water erosion. Since this is characteristic of much of the Southwest, Mexican Springs findings as to erosion control and run-off have been found applicable to many other parts of Region 8.

WHEN the station was established there was little information for the Southwestern range country, on action of silt and run-off, and on erosion control measures. During its early years, therefore, almost every conceivable erosion control measure was given a trial, and silt and run-off were studied.

In the past 2 years the station has narrowed its research activity to two main groups—diversion flooding and run-off from complete drainage areas.

In the run-off studies, nine representative drainage areas under controlled grazing, and three outside the area, under common use, are systematically studied. The largest drainage area comprises 46,000 acres, and the smallest only 187 acres.

Rain gages and recording stream-flow gages are spotted at strategic points throughout these drainage areas so that the amount and intensity of rainfall, the storm pattern, and the run-off can be adequately recorded. During actual flows, samples are taken and analyzed for silt and salinity. Data are correlated with the amount of run-off, the duration and pattern of the storm, and the vegetative and grazing factors involved, to get the whole picture of how much silt and water can be expected from a certain type of country with a certain kind and amount of rain.

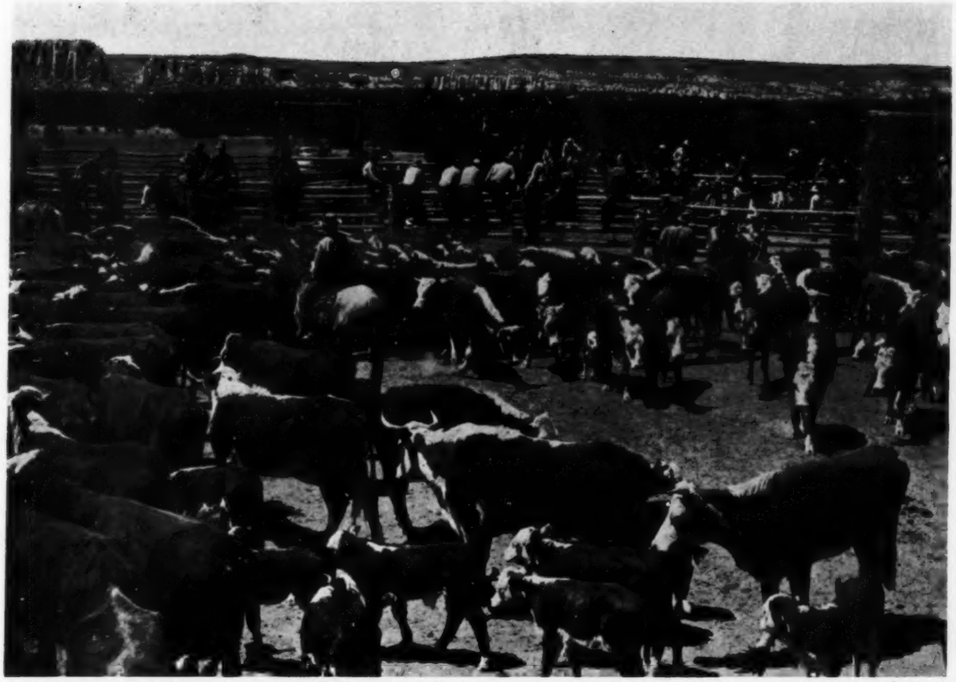
These studies yield data helpful in determining the relation of run-off to rainfall—information essential to proper designing of erosion and flood control structures and useful for guidance in watershed treatment.

Possibly of more immediate interest are experiments in the field of diversion flooding. Flood waters are taken out of arroyos and spread on crop and range lands, in an effort to develop methods effective in the stabilization of soils and the conservation of water.

For studying the effects of flood waters on soil and

[1] Regional conservator, Soil Conservation Service, Southwest Region, Albuquerque, N. Mex.

[2] Project supervisor, Navajo Experiment Station, Soil Conservation Service, Southwest Region, Mexican Springs, N. Mex.



Acoma stock owners watch branding and dehorning operations in May, when cattle are rounded up in the drive from winter to summer ranges. Juniper woodland characteristically surrounds the corral.

vegetation, field and plot studies are under way. While no control is exercised on water flow in the field studies, water reaching the plot studies is controlled as to amount, or kind, or both.

In the plot studies, the smaller plots, all planted to native grass, are divided into several series, which receive controlled mixtures of water and silt; amount and kind of silt varying with the series. Of the larger plots, each 1/100-acre in area, some are planted to native grasses, the others to crops. Certain of the grass plots receive a 6-inch application from every flow coming down Mexican Springs Wash; some receive clear well water; still others receive only rainfall. The crop plots are divided into series to test the effects of applying to certain ones portions of each flow coming down the wash, and of applying to others, flows selected for timeliness and for silt content.

Measurements are made of crop yields, quantitative and qualitative changes in vegetative cover, and physical, chemical and bacterial changes in soil, to determine the effects of the various treatments.

AS AN important phase of the broad program designed to prevent excessive soil and water losses through accelerated erosion, a livestock and range management demonstration was undertaken on the 43,000-acre area under fence. This demonstration was designed not only to test methods in rehabilitating range lands but also to find what effect reducing grazing to intensities commensurate with the existing vegetative cover would have upon the income netted by the area.

Because the area had been heavily overgrazed prior to the establishment of the station, the first step was to reduce to proper numbers the Navajo sheep, cattle, and other stock grazing within the station boundaries. After the area was fenced, all livestock was removed. Surveys showed the estimated carrying capacity to be 1,854 sheep units. This amount of stock was returned to the area for study and demonstration of proper livestock and range management.

Of the 1,854 sheep units, 500 are now purebred Rambouillets, and 500 are mixedbred Navajo sheep. Purebred Hereford cows make up 320 sheep units, and 534 sheep units are in miscellaneous stock such as horses, rams, stallions, and bulls.

In addition to records on the livestock within the area, the station staff has also kept records on yields and returns from typical livestock outside the experimental area.

For comparing results under proper management

Badly overgrazed Laguna reservation range is slow to come back. Sacaton grass beyond fence is far from back to "original condition," but one growing season without grazing has given it a lush appearance compared with that of the annuals outside the fence. Stock was excluded, water was spread, to aid natural vegetation.

within the area with results under ordinary Navajo management outside the area, the former number of sheep units grazing the area was estimated to be 3,700. This is based on the fact that the station was located within, and was typical of, district 14 of the Navajo Reservation, where range surveys and livestock counts showed that the estimated carrying capacity was 50 percent of the total number of stock grazing within the district.

The management program includes use of range by both cattle and sheep because (1) the Navajos around Mexican Springs originally had a few beef cattle in addition to sheep and wanted to continue some dual usage, and (2) flood irrigation tests and erosion control treatment afforded range that could be used more efficiently by cattle than by sheep.

The program to improve Navajo sheep has been planned as part of the operations demonstration work upon the Navajo lands. Earlier studies by the Indian Service indicated that erosion control was intimately related to a more efficient production of mutton and wool. This program calls for the use of high quality rams and the careful culling of each flock. It does not contemplate selective breeding for new types, such as that carried on at Fort Wingate by the Bureau of Animal Industry and the Indian Service. A flock of purebred sheep has been grazed in the area for the 5-year period, 1935–39. The mixedbred sheep of the Navajos, however, were introduced to the station range less than 3 years ago. The period 1937–40 has been too short for the breeding improvement program to bring results in increased production. The mixedbred sheep inside the area are, so far, of about the same quality as the mixedbred sheep outside.

The following tables of results therefore reflect, for the mixedbred sheep inside the area, production increases due only to reduced stocking and proper management.

Production records of the Rambouillets show that the Navajos can run purebred sheep and, with proper management and curtailed numbers, boost their income as much as 37 percent per acre.

Data are not yet available to show how long it may take for the income of the properly managed Navajo herd, through careful breeding, to approach the purebred herd income. With careful teaching of breeding and culling practices, it is hoped, however, that this point may be reached in 10 years.

The station does not anticipate that all Navajos will have purebred sheep. It does, however, expect that the ordinary Navajo sheep will be vastly improved in type.

In the demonstration the Indians have been handling the native mixedbred stock themselves, paying all bills and buying salt.

Tables 1 and 2 illustrate the effect on yield and return of proper livestock management.

TABLE 1.—*Yields from Navajo mixedbred sheep and purebred Rambouillets*

	Ewes	Lamb crop	Average fleece weights	Average lamb weights	Average death loss
	Number	*Percent*	*Pounds*	*Pounds*	*Percent*
Mixedbred sheep inside area*	500	75	5	55	6
Mixedbred sheep outside area*	500	55	4	50	15
Purebred sheep inside area**	500	92	11	64	6

* Records for 1937–39. ** Records for 1935–39.

In 1935, Navajos in the Mexican Springs area purchased a herd of purebred Hereford cattle from the drought area of western Texas. In 1939 the cows were pooled into an owners' association, with each

TABLE 2.—*Returns from Navajo mixedbred sheep and purebred Rambouillets*

	Average price per pound		Gross return per ewe
	Wool	Lambs	
	Dollars	*Dollars*	*Dollars*
Mixedbred sheep inside area*	0.174	0.0615	3.40
Mixedbred sheep outside area*	.174	.060	2.33
Purebred sheep inside area**	.190	.073	6.39

*Records for 1937–39. ** Records for 1935–39.

owner issued shares in the total herd. The Navajos paid for these cattle out of the herd's increase, and, since the formation of this association, records on cattle yield and return have been kept. Improved range and livestock management shows increased returns in beef production as well as in lamb and wool production, as shown in table 3.

TABLE 3.—*Yields and returns from Navajo cattle of fair grade and purebred cattle, 1939*

	Mature cows	Calf crop	Death loss	Average calf weight	Average price per pound	Gross return per cow
	No.	*Pct.*	*Pct.*	*Lbs.*	*Dols.*	*Dols.*
Purebred cows inside area	50	94	2	462	0.09	38.25
Grade cows outside area	40	60	0	350	.06	12.60

Since part of the station area has dual usage (cattle and sheep) the gross returns may well be figured on that basis. The average gross return for all livestock, converted into sheep units, is $6.45 per sheep unit. On the other hand, the gross returns for sheep and cattle on the Navajo range outside the area is $2.74 per sheep unit. However, because of the reduction from 3,700 units to 1,854 units within the station's range area, the unit gross income inside should be compared with the gross income from two units outside. This makes gross return per unit inside the area $6.45 as contrasted to $5.48 outside. In other words, the Mexican Springs Navajos have earned more from 1,854 sheep units properly managed, and under dual usage, than they would have from 3,700 sheep units, had no reduction or management changes taken place within the area.

On an acreage basis, the Mexican Springs Navajos earned 15 percent more where livestock was properly managed and under dual usage than did those outside the area. The gross returns show that the Mexican Springs area produced 16 cents per acre as compared with 14 cents per acre outside, on the same number of acres with twice the stock.

In other words, the Navajo Experiment Station is beginning to show the Navajo stockmen that their livestock income can be maintained and possibly increased, under a system which protects and improves their chief resource—range land.

Equally as significant as the yield and return statistics is the recovery within the boundaries of the station. Gullies, with little or no special treatment have generally healed, their bottoms and sides have become stabilized by grass. Well-sodded western wheatgrass and blue grama slopes contrast sharply with bare, eroding soils outside the area where the chief perennial vegetation is scattered clumps of snakeweed and pingue. There is evidence that the carrying capacity of the area has increased, possibly doubled, in portions of the higher rainfall belt and in flood-irrigated areas.

If it had done nothing else, the project would be well worth while for its demonstration of the value of proper grazing practices in erosion controol.

TZINTZUNTZAN TO SINGAPORE

(*Continued from p. 57*)

those in the eroding fields had fallen far below yields obtained from the non-eroding field, which has held up to its original output.

When I asked the farmer how much the conservation work had reduced erosion in the eroding field, he replied without hesitation, "Ninety-eight percent."

Our visit to that part of Michigan ended that night with the crowning of Miss Barbara Brown, of St. Ignace, as Queen of the National Cherry Festival. Since then my thoughts occasionally have skipped back and forth from the drifting sands and eroding fields and orchards cultivated up and down so many of Michigan's slopes to the gullies of Tzintzuntzan and the benched slopes south of Mexico City. What comes of this mental skipping from field to field across the Rio Grande is the conclusion that when we fail to defend our productive land, we eventually lose by that neglect our heritage of productive soil—the foundation of liberty, happiness, prosperity, and national virility and security.

With the kind of cooperation I found in Michigan—the fine teamwork among farmers and specialists, both Federal and State—I am confident that the good work we saw in fields and orchards, on drifting sands and eroding slopes, is going to be carried steadily forward toward our goal of security for the land, and the people, and the Nation itself.

POSSIBILITIES OF JOHNSON GRASS IN NORTHWEST TEXAS

By HENRY M. PEVEHOUSE [1]

Stubble of a good stand of two-year-old uncultivated Johnson grass on sandy soil heavily grazed with sheep in 1939. This picture was taken in March 1940 after three severe dust storms, one of 36 hours' duration.

JOHNSON GRASS, which in many areas is considered a serious pest or a pernicious weed, may prove to be a great boon to agriculture and an important addition to the grazing economy of the livestock-feed-grain area north of the Canadian river in Texas. While distributed through 33 States it has never been common to this area and it is most prevalent in the South.

Many States have passed stringent laws regarding the selling or transporting of Johnson grass seed, the planting of the grass or allowing it to go to seed, sometimes even penalizing the very existence of this grass on lands owned by individuals, corporations, or others. The Oklahoma law, for example, provides that failure on the part of a person or corporation owning or controlling land to remove Johnson grass from such land within a specified time after being served with a notice of complaint subjects him to a fine and penalty. Furthermore, the county commissioners may then enter the property, remove the grass and charge up the cost thereof in the form of a tax lien. Kansas has a law against selling the seed but does not prevent its being planted. Texas laws are especially directed toward irrigation companies and railroads allowing the grass to go to seed along their ditches or rights-of-way, but Texas does not prevent the selling of the seed or the planting of it on one's own land.

This article describes the growth and utilization of the grass in the area centering around Dallam and Hartley Counties, Tex. Here there is an urgent need for a perennial cultivated or semicultivated plant which combines the advantage of being a good soil binder with that of having satisfactory economic possibilities. Johnson grass seems the nearest approach to such a plant yet found.

[1] Assistant soil conservationist, Soil Conservation Service, Southern Great Plains Region, Amarillo, Tex.

Physical Characteristics

Johnson grass (*Sorghum halepénse*), a highly palatable perennial grass native of the Mediterranean area, belongs to the sorghum tribe of cultivated grasses. It resembles Sudan grass in appearance and, although it does not usually grow as tall, it may be distinguished from Sudan by its root stocks which are about the size of an ordinary lead pencil. These regenerative roots, or rhizomes, which cluster under the crown of the grass and lie dormant during the winter season, extend down and outward from 1 to 4 or 6 feet. They are jointed in 1- to 2-inch sections and at each joint may send out either small fibrous feeder roots through the soil, or grass shoots above the surface, or both. Thus, any root when partially or wholly covered with several inches of soil and consisting of two or more sections with an unimpaired joint, may in favorable weather take root and send up stems or shoots. Farmers who have had from 6 to 10 years' experience in growing the grass in this area report that this root clump, when once started and if left undisturbed, will multiply and spread underground, take root at each joint and send up shoots from as many of the joints as is necessary to sustain life and balance growth of the root clump below the surface.

The shoots or stalks grow rapidly in normal weather, and if unmolested they will make seed within 60 to 75 days in this area. Climatic conditions, however, especially mositure, are not always favorable to full maturing of seed; hence, indications are that the grass will spread very little through volunteer seeding.

One of the marks of a good erosion-resisting plant is the nature of its root system and its ability to hold the topsoil. The extensive and tenacious root system close to the surface and the large amount of top growth make Johnson grass a good soil-binder and soil-builder. If cultivated frequently after being established, Johnson grass will resist erosion on all types of soil. It need not be disturbed by plowing until after the worst windstorms of March and April. Even then listing or chiseling, the most common methods of

tillage for erosion control in this area, are the methods generally used in cultivating Johnson grass.

Old uniform stands of grass which have been cross-listed for root distribution furnish good grazing and show almost a solid ground cover. This cover, even when grazed very closely, is sufficient to prevent damaging wind erosion even on the sandier soils.

Seeding and Harvesting

Johnson grass may be established from the rhizomes, but the cost of extensive establishment by such practice would probably be prohibitive. In this area, the grass usually is started from seed, and during the first year of growth it is known as seedling grass to distinguish it from grass sprung from the rhizomes.

Seeding of Johnson grass is at the rate of about 5 pounds per acre, planted with a lister 3 to 4 inches deep in 36- to 42-inch rows. Planting is usually from June 1 to June 15. Normally, seedling grass is cultivated once for weed control. If it is to be harvested for seed, two cultivations may be in order. Once established, the grass will come up from the root stocks every year thereafter. If not plowed or broken up occasionally, the grass tends to become "rootbound" and dies out gradually after 3 or 4 seasons. This is especially true on clay soils. Therefore, for best growth and also for weed control it should be broken up or listed every second or third year, preferably at right angles to the previous listing or planting, to obtain wider distribution of the roots. Some farmers plow Johnson grass every spring just after it starts coming up. It thrives better under such treatment and, furthermore, the first crop of weeds is killed.

To harvest for seed, the grass is mowed, raked, and stacked, or it may be cut with a binder. The seed must be fully matured before cutting. If harvested for forage or silage, Johnson grass usually is bound at about the time it is fully headed out, but before the seed begins to ripen. At this stage, it is more palatable because it is greener and less stemmy. In this area harvesting is by grazing.

Production and Utilization

Johnson grass which has become well rooted in previous seasons will sprout out in late April or early May. Within 10 days (weather permitting) it will be from 2 to 5 inches high and ready for grazing. Grazing starts around May 15. Grass 2 to 5 years old which has been spread by cultivation will furnish from 2½ to 7 cow months of pasture per acre. While the best grazing season is from May 15 to September 30, cattle and horses will eat it, especially the lower leaves close to the ground, as long as it stands, which may be as late as January 1.

During the growing season the grass will withstand heavy grazing. Cattle, sheep, and horses prefer the young tender shoots or stems to older grass. If these stems are cut or grazed off during the growing season, they sprout or sucker out again immediately and in favorable weather may grow as much as 2 inches within a 24-hour period. If a field appears to be suffering from overgrazing, removing the stock from it for a week or 10 days ordinarily brings full recovery. In exceedingly dry weather from 2 to 4 weeks' rest, or a light shower, may be required.

Because of its slow growth, seedling Johnson grass is more difficult to establish than other sorhgums. Even seedling grass that is well established will furnish scarcely one-half as much grazing during the first year as will old root-sprung row stands, and probably only one-fourth as much as old well-scattered, cultivated stands. A seedling field west of Dalhart, Tex., produced 350 pounds of cleaned seed per acre in 1939, the highest yield recorded in the area. Being less vigorous and less highly competitive during the early stages of growth, Johnson grass does not thrive when seeded in a mixture of Sudan, cane, and other sorghums.

As to forage production, good, old stands of Johnson grass produced as much as 1,000 bundles, or about 5,000 pounds of dry forage per acre in 1939. One field of mixed cane and Johnson grass produced 6 tons of silage per acre and, in addition, 4 to 5 cow months of pasture per acre, later in the season.

Inasmuch as Johnson grass in this area usually is planted on abandoned or badly eroded cultivated fields from which little if any economic return has been expected, still less realized, any appreciable returns beyond expenses are welcomed. Individual experiences with the grass have been highly satisfactory.

Cecil Jones of Dallam County reports the equivalent of 2 cow months of sheep pasturage per acre on 540 acres of second-year, uncultivated grass. His lambs made total net gains of 62½ pounds per acre, which at 6 cents per pound grossed him $3.75 per acre. Mr. Jones' sheep grazed on a section which contained 100 acres of native grama and 540 acres of Johnson grass. The sheep, having access to both, grazed the Johnson to the ground, but allowed the grama to head out. On 120 acres of 5-year-old grass which had been listed several times, including once in 1939, 120 yearling steers grazed for four months, and, later, 100 head of cows for 2 months. The steers without any other feed gained an average of 250 pounds, or more

than 2 pounds per day. They weighed around 700 pounds when sold from the field and topped the market at 8 cents—a gross of $20 per acre. This was on good, deep, sandy land with more than average moisture. It seems probable that Mr. Jones permitted too close grazing of this field. This is partially substantiated by the fact that the grass came out slowly and thinly in the spring of 1940. However, a hard freeze on April 12, 1940, resulted in severe damage to the rhizomes, and set the grass back at least 30 days.

Grover Swift filled a 640-ton trench silo from a 160-acre field planted in 1939 with a seed mixture of three-fourths cane and one-fourth Johnson grass by weight. Immediately after cutting, this field furnished the equivalent of one-half-cow month of pasture per acre. While the Johnson grass forage production was negligible compared with the cane, a thin but evenly distributed stand was obtained. This planting procedure will be continued according to Mr. Swift, until a satisfactory stand of Johnson grass has been obtained, at which time the field will be scalloped, disked or listed once or twice each year and utilized for grazing.

The same year Mr. Swift also planted to Johnson grass 2,560 acres of severely eroded land that had been abandoned a number of years. Four pounds of seed per acre were planted in 42-inch rows with a lister. A fair stand resulted. Mr. Swift intends to continue to replant and work this land until the soil has been completely stablized with a cover of Johnson grass, after which he will use it for pasture.

Mr. Vinson, of Hartley County, grazed 90 head of mixed cattle for 7 months on 90 acres of 4-year-old grass, which was cultivated in 1938 but not in 1939. Many others realized from 2 to 5 cow-months of pasturage per acre, depending somewhat on the condition and the age of the grass and the manner in which it was utilized. Some farmers grazed their grass very close, never allowing it to grow more than 8 to 10 inches high. Others used the grass less intensively, allowing it to attain a height of 2 to 4 feet, to get stemmy and to head out. The former practice will produce best results, as the grass is more palatable when young and tender.

Due to a mild winter and adequate seasonal moisture early in the spring of 1939, Johnson grass as well as all other sorghums probably made better than average growth throughout the year.

Johnson grass does best in this area on deep sandy soils with the normal 14- to 18-inch rainfall. It will, however, produce satisfactorily on heavy loam soils and with less rainfall. Indeed, it is noteworthy for yielding worth-while returns under conditions of rainfall which would discourage annual sorghums. This is evidenced by the fact that Johnson grass did well here during the period 1934–39 inclusive, when the average annual rainfall at Dalhart was 12.72 inches.

Use Limitations

Because of the difficulty of eradication, Johnson grass is not recommended for use on any land which is later to be cultivated regularly to annual crops. The tenacity of the root system in maintaining the grass after it has been established in this area has not been fully measured; it is likely however, that extreme and costly methods of eradication such as deep plowings in the hot dry summer months, or plowing in the winter when the roots can be turned up and allowed to freeze, would be necessary to kill it out. Johnson grass is not recommended on lands where wheat or other grain crops are being grown successfully.

Johnson grass planted on shallow, poor soils and shallow-phase silt and clay loams is difficult to maintain even under the most favorable circumstances. Furthermore, in this area Johnson grass is not a permanent perennial, as it is in more humid climates. Here it is a semi-cultivated crop, and unless the roots are broken up and scattered occasionally they tend to become root-bound and make little if any growth above ground. On the other hand, although all of the roots may then appear to be dead, many are in reality only dormant and will start growing if disturbed. Thus, if the ground is broken up during the spring and seeded to annual crops, the Johnson roots will immediately sprout out, use up the moisture in the soil, hinder the growth and necessitate more cultivation of the annual crop.

Some caution is necessary in grazing Johnson grass to prevent losses of livestock from poisoning. The consensus of opinion of agronomists and other technicians regarding the danger of prussic-acid poisoning from the grazing of Johnson grass is that the danger is no greater than that from other plants of the sorghum tribe. In 1939 only one record of poisoning was found in this area, whereas several farmers lost cattle from poisoning by native plants. While little is actually known concerning the formation of toxic acid by plants, it is now thought that Johnson grass will develop this acid in the wilt stage during a hot dry spell. Some farmers who have had experience with Johnson grass claim that it is reasonably safe to graze it after it greens up again following a drought period.

(*Continued on p. 77*)

SIZE OF FARM AND THE SOIL CONSERVATION PROGRAM

By GEORGE W. COLLIER [1]

INCREASING the size of farming unit sometimes becomes a vital part of soil conservation. Large numbers of farms are too small to return an income adequate to meet minimum standards of health, education, and individual and community well-being. Small farm sizes have tended to use the land to increase current revenues at the cost of long-time production and income. Besides encouraging a land use resulting in a wastage of soil, small farming units have made it necessary to use for living purposes that part of the income which, to prevent future declines in production, should have been spent for soil-conserving practices.

It is shortsighted to formulate farm plans which result in inadequate incomes. Such plans manifestly cannot be adhered to indefinitely—neither can even the low incomes provided be kept from dropping further in the face of continuously depleted resources. The ideal should be to formulate farm plans resulting in adequate incomes which are maintainable over a period of years. Such planning naturally is based on a conserving use of land resources.

The making of conservation plans without attention to minimum income possibilities is similar to building a dog kennel to house a horse. A conserving land use and an adequate farm income are essential to a lasting farm plan.

Sometimes, it is true, the volume of business and the income can be increased without adding to the size of farm. Even with a reduction of cultivated land or of acreage of the highest value crop, there is oftentimes an opportunity to intensify the organization in other respects. Yield per acre of the reduced crop acreage may be increased by more intensive cultural practices, or crops and livestock may be shifted to types of production that are more intensive in use of labor, fertilizer, etc. For instance, dual-purpose cattle and chickens might be increased to offset decrease in production of fat cattle and hogs; or, a small acreage of canning and truck crops might replace part of the corn. Only where such opportunities are not present does it become imperative that farm size be increased to maintain both income and land resources.

While the size of business on small-farm enterprises should be intensified wherever practical, there are many instances wherein enlargement of units is desirable. More skill in management is usually required to operate intensively a small unit than to practice the usual type of farming on a larger acreage. The general increase in volume of business on small units would result in a more difficult marketing problem than that resulting from increased volume of business brought about by enlarged farm boundaries.

In many areas in the United States, acreage per unit seems to be directly associated with productivity per acre—the better the land the larger the farm, or, conversely, the poorer the land the smaller the farm. A greater change in land use is often indicated on small farms of low productivity than on larger and more fertile farms. Moreover, this change often causes a relatively large sacrifice of current income that is already very low, in order to maintain that income over a longer period. In such instances, size of farm has been a major factor in harmful exploitation of soil. Conservation will not be achieved on such farms until unit sizes are increased or farm incomes are supplemented in some other way.

In many sections of the country land use is not suited to soil and climatic conditions. Although this is especially true in the Great Plains, particularly in the Northern Great Plains, it is by no means confined to this region. In many areas the small size of the farm has forced the farmer to practice more intensive farming with more land in cultivated crops over a period of years than is justified by the soil and climatic environment. While in favorable years this may produce much more income per acre than would a more conservative use of the land, in unfavorable years it is hazardous from the point of view of both current income and loss of soil resources by erosion.

In the Northern Great Plains, the effect of a cash-crop system has often been such as to cause soil losses by erosion in unfavorable climatic seasons. Often it is impossible to initiate an effective soil conservation program without greatly decreasing acreage of cultivated land; and where size of farm is geared to production of cultivated crops, the farm may not be large enough to afford adequate operations under a grazing system. Thus, if income is to be maintained, change in type of agriculture will necessitate increase in the size of many farms. The Bureau of Agricultural Economics recognizes the need of increasing farm-

[1] Assistant, farm management section, division of farm management and planning, Soil Conservation Service, Washington, D. C.

unit size in the Great Plains in order to increase and stabilize farm income and maintain land resources. The Bureau reports as follows:[3]

Many of the farms in the Great Plains have been found too small to provide a sufficient surplus in good years to carry them over the inevitable bad years. Small acreages have also contributed to erosion problems since on the small farms there has been a tendency to place too large a proportion of the land in crops, leaving the soil unprotected against wind erosion.

Permanent rehabilitation of farmers would involve an increase in the size of some farms, retirement of some land from crops, an increase in pasture acreage, immediate or eventual replacement of depleted livestock herds, repairs to buildings, and repairs or replacement of machinery.

The county planning report for Hill County, Tex., where attention has been given to farm sizes, recommended that the number of farms in the county should be reduced by 23 percent. For specific subareas within the county the recommendation varied from no change to an average of 50-percent increase in size.

The 1939 annual report for the Northern Great Plains Region of the Soil Conservation Service (p. 22) states that:

Probably 50 percent of the operating units in soil conservation district work areas are of an inadequate size to organize the farm for sound management and still enable the farmer to obtain an adequate income without additional assistance. * * * In many respects tax-adjustment, debt-adjustment and adjustment in size of operating units are almost required preliminaries for the execution of a sound soil conservation program.

Although need for increasing farm unit size has been most closely associated with areas of hazardous climatic conditions, it exists also in the humid regions. Ohio Agricultural Experiment Station Bulletin 604, "The Relationship Between Soil Maintenance and Profitable Farming," reports a study of 10 areas in that State showing that "there was a tendency for larger-than-average farms to have a better productivity balance than small farms. In other words, owners of small farms generally find it necessary to have a high proportion of their land in soil-depleting crops."

Missouri Research Bulletin 308, "Relationship of Productivity of Farm Units and Their Ability to Pay Rent," points out that "a farm unit must exceed a certain minimum size and a certain level of productivity if it is to provide a living for the farm family and pay the cash costs of production." A unit might have "just enough physical production to supply an adequate living and pay the necessary variable and fixed expenses but give no net return to the landlord." The fact that a farming unit is too small to pay rent does not mean that the land is submarginal in productivity. It does mean that such a farming unit will not provide a living for the operator, pay cash expenses and rent, and is therefore submarginal on account of size.

The above quotations for Ohio, Missouri, and the Great Plains, together with similar evidence in the Southeast, show that the need for increasing size of farm represents an obstacle to conservation planning in several parts of the country. Many farms too small to allow formulation of a plan to produce adequate income and maintain resources could be planned as part-time farms. Unfortunately, however, thousands of such farms do not have employment opportunities for supplementing the small incomes from their land resources, and in the attempt to increase immediate income by exploiting the land they reduce subsequent production and income to a still lower level. If conservation of land resources is to be achieved it is important in several regions that ways and means of decreasing size of farm be considered.

In many areas where it is necessary from the standpoint of a soil conservation program that size of unit be increased, a high percentage of rented land is owned by persons living outside of the county or State; this makes the problem more difficult because of lack of appreciation by the owner as to what constitutes the best long-time use of the land and the loss of resources from improper land use. Much may be accomplished in such areas by arranging with owners of contiguous land to round out units that might be placed on a more stable and permanent basis. This may be done by an operator's leasing of adjoining absentee-owned land.

Leases should be made for longer than the usual 1-year basis for the long-time land-use plan. A farm conservation plan is essentially a long-range plan. Benefits from crop rotation, pasture establishment, and proper use of range cannot be realized in a single year. If a tenure of at least 5 years could be assured, the tenant would realize the benefits from soil-conserving practices and would be more likely to put a farm conservation plan into effect. Greater security of tenure would give farm and ranch operators a longer planning perspective and would help greatly in stabilizing the application of such plans.

During the past 2 years the Southern Great Plains Region of the Service, in cooperation with the Farm Security Administration, has done considerable work in improving farm organization by increasing size of operating units. The units for reorganization have been selected jointly by these two agencies. The operator of the unit is ordinarily a Farm Security Administration client, selected because he has the

[3] W. P. A. Research Monograph XVI "Farming Hazards in the Drought Areas." By R. S. Kifer and H. L. Stewart, Bureau of Agricultural Economics.

necessary interest and ability for managing and operating the reorganized unit successfully.

Increase in size of unit was obtained in most instances through the leasing of additional land owned largely by absentee landlords. Where possible, leases for 5 years or longer were negotiated for the operator, and the Service assisted in drawing up a plan to utilize the resources of the enlarged unit. The Farm Security Administration lent money for purchase of breeding stock and other items necessary for operation of the farm and home.

Experience to date indicates gratifying results of the initial efforts in this direction. The average acreage of 125 reorganized units established before June 1, 1939, consisted of 285 acres of cultivated land, 220 acres of restoration land, and 1,813 acres of pasture. An average of 4.4 ownerships of lands have been consolidated into one operating unit as a result of this program. Many of these cooperators already have completed the soil and moisture conservation structures planned for construction over a 5-year period. Economic progress of these operators indicates that the majority of them will pay up their original loans before the end of the loan period. In other areas, the Farm Security Administration has been active in increasing size of operating units without the assistance of the Soil Conservation Service.

The tenant purchase activities of the Farm Security Administration can be used for setting up adequately sized units on some farms in many communities. Although a high proportion of indebtedness is involved, the greater degree of control by the operator over the land under his management has definite advantages over short-term crop-share leases. Ownership of an adequately sized unit with low interest rates gives the operator the long-time planning perspective necessary for best use of soil resources over a period of years.

In management of land acquired by public agencies, there is also opportunity to increase volume of business on farming units that are too small for minimum income expectancy. Allotments in community grazing associations, or the renting of blocks of this acquired land, can be made very effective in making small units more nearly adequate. Permits and allotments on national forest land and public domain can be granted in such a way that some progress can be made toward a minimum size of unit objective. In some areas, soil conservation districts can obtain control of abandoned homesteads and county or other public land to help in blocking up more desirable operating units.

The production credit facilities and the land bank loans of the Farm Credit Administration can also be used in effectuating desirable changes in farm organization. The important thing is to have clearly in mind the economic potentialities for a specific combination of enterprises in a specific area. Plans should not be made that do not promise income sufficient to meet minimum living standards for the operator over a period of years. A conserving use of the land is essential if the income base is not to be destroyed. Effective farm planning involves the balancing of a proper intensity per acre with a sufficiently extensive area to provide income situations that can be projected with some assurance into the future.

Enlarging the size of farming units should not be looked upon as a separate part of the planning program but should be an integral part of it. In many instances it should be a definite part of the work in soil conservation districts and be given prominent consideration in the district program and work plan. Except for a limited number of reorganized units outside organized districts to serve as effective extension demonstrations, the most efficient use of the time of planning technicians of the Soil Conservation Service will probably mean the restriction of this activity to areas included in districts. The availability of machinery, and in some cases C. C. C. labor, as well as the need for follow-up in the application of farm plans, is another reason for considering the advisability of confining emphasis on unit reorganization by the Service to soil conservation districts.

In some areas a general increase in the size of farms means no decrease in the number of operating units. Many farms may have been abandoned following a succession of crop failures so that an increase in size of existing operating units would mean bringing idle or abandoned land into a conserving and productive use. This would make possible a less intensive use of land in the existing operating units without decreasing current income possibilities. The presence of large numbers of idle or abandoned units in the Great Plains suggests that the need of and the opportunity for enlarging farm boundaries is perhaps greatest in the Northern and Southern Great Plains Regions.

The need for increasing size of farms in connection with a more extensive use of land is found in many areas where the ratio of farm population to land resources is even narrower than in the Great Plains. In these circumstances the difficulty is often expressed by the query, "What are you going to do with the people?" In such instances, long-time objectives often must be compromised with immediate possibilities

(Continued on p. 77)

WATER CONSERVATION IN AN IRRIGATION SYSTEM

By EUGENE C. BUIE [1]

SEEPAGE loss in the distribution system of the Buckeye Lateral Ditch Association was 45 percent of the total water received in 1937. This association obtains its water from an irrigation company. Such an enormous percolation loss was a serious matter to the farmers constituting the membership. Not only did these farmers pay for water which they did not get but their crops suffered from a shortage of needed moisture. To find a solution for this problem, they asked assistance from a Soil Conservation Service C. C. C. camp located near Wellington, Colo.

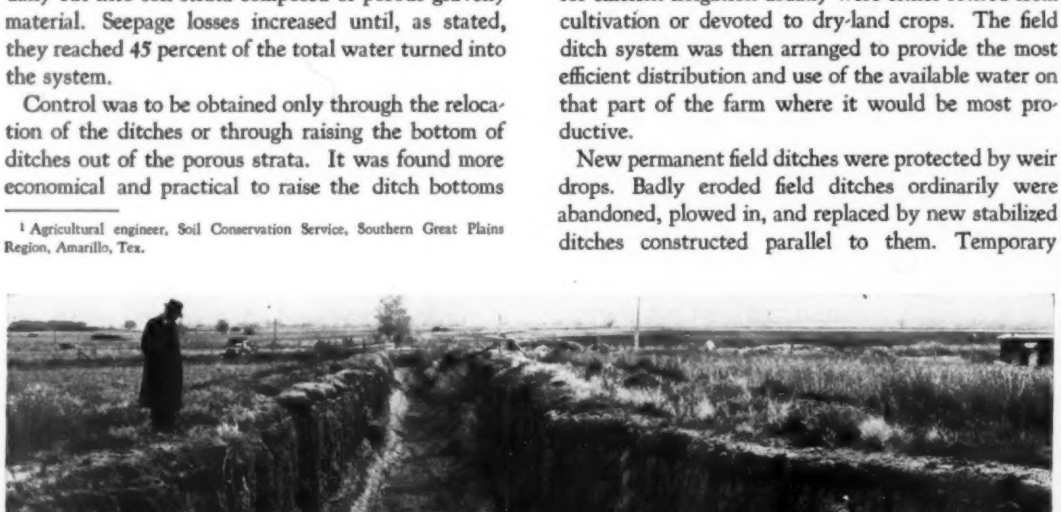
The main distribution ditches generally were located on section or half-section lines without regard to grade. As a result, the fall often was from 50 to 60 feet per mile. The sandy loam and sandy clay loam soils of this locality will not stand the resulting high velocity. The ditches eroded rapidly and eventually cut into soil strata composed of porous gravelly material. Seepage losses increased until, as stated, they reached 45 percent of the total water turned into the system.

Control was to be obtained only through the relocation of the ditches or through raising the bottom of ditches out of the porous strata. It was found more economical and practical to raise the ditch bottoms by means of rock masonry drops than to construct new ditches. The masonry drops not only raised the ditch bottoms but also provided a permanently stabilized grade. Twenty-four such structures were built in 2½ miles of the Buckeye lateral ditch. It is anticipated that the remaining 9½ miles soon will be stabilized in a similar manner. The banks of exceptionally deep sections of ditch were often plowed in to expedite the sealing of porous strata and also to provide a more desirable cross section.

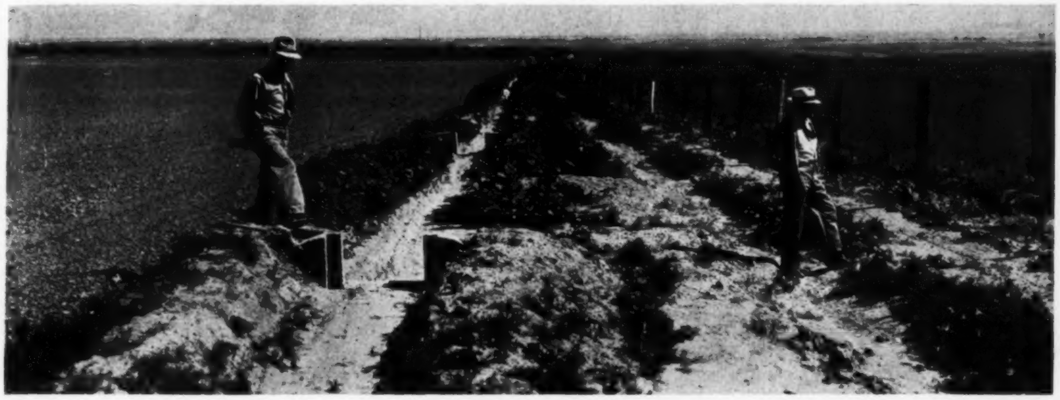
The assistance of the C. C. C. camp was by no means limited to the main distribution systems. Individual farm irrigation systems were revamped to provide better distribution and more economical utilization of water. Changes in each farm irrigation system were based on careful study of soils, slopes, topography, and adapted land use. Shallow soils and slopes too steep for efficient irrigation usually were either retired from cultivation or devoted to dry-land crops. The field ditch system was then arranged to provide the most efficient distribution and use of the available water on that part of the farm where it would be most productive.

New permanent field ditches were protected by weir drops. Badly eroded field ditches ordinarily were abandoned, plowed in, and replaced by new stabilized ditches constructed parallel to them. Temporary

[1] Agricultural engineer, Soil Conservation Service, Southern Great Plains Region, Amarillo, Tex.



Typical condition of main distribution irrigation ditches prior to installation of stabilization structures.



Relocated, stabilized field ditch. Depression on the right is location of old ditch which was too deep to stabilize economically.

field ditches were laid out on established grades, their spacing regulated by the most efficient length of run for soil type and slope. The use of ditch lines as crop boundaries proved very satisfactory. By careful planning, it was often possible to use waste water for the irrigation of windbreaks.

It is difficult to evaluate accurately the benefit of this work to the community. William O. Evans, secretary of the association, stated that seepage losses already have been reduced to approximately 14 percent by the stabilization of only these 2½ miles of the main ditch. This means that during the 1939 irrigation season 31 percent more water of the total amount delivered was available to the farmers than would have been otherwise. This is a saving, according to Mr. Evans, of 672 acre-feet, or $1,629, to members of this ditch association, based on a 28-year average of appropriations and assessments. In terms of 50 shares per farm unit, each farmer realized a saving of $110.83 in the water delivered to his farm.

Additional savings accrued where the farm irrigation system had been revised.

E. F. Munroe, president of the irrigation company, says, "This system has proved very effective. It has decreased ditch erosion to a minimum and made it possible to use all of the available water on crops, undoubtedly causing a decided increase in crop yields."

Mr. Evans, association secretary, speaks as follows: "Stabilizing ditches on my farm has helped reduce water loss and made irrigation of crops easier. I believe crop yields will be increased, but as yet I have not compiled any data to show results."

Fred Krumdick estimates that water supply on his farm was increased 25 percent and his crop yields 15 percent. Charles M. Holtcamp declares that his effective water supply was increased at least 5 percent by his farm distribution system and that his crop yields were increased 20 percent as a result of the work done by the camp.

The results clearly indicate the practicality of conserving irrigation water. Planned conservation, distribution and use of irrigation water in accordance with the principles of good land use and erosion control have not only proved valuable to irrigation farmers but have also broadened the constructive program of the Soil Conservation Service.

Approximately 1,000 water-facility projects are now under way in the 17 Western States. When completed these facilities will benefit about 1,700 families, make available for irrigation more than 50,000 additional acres, and place under conservation farming practices over 1,141,000 acres.

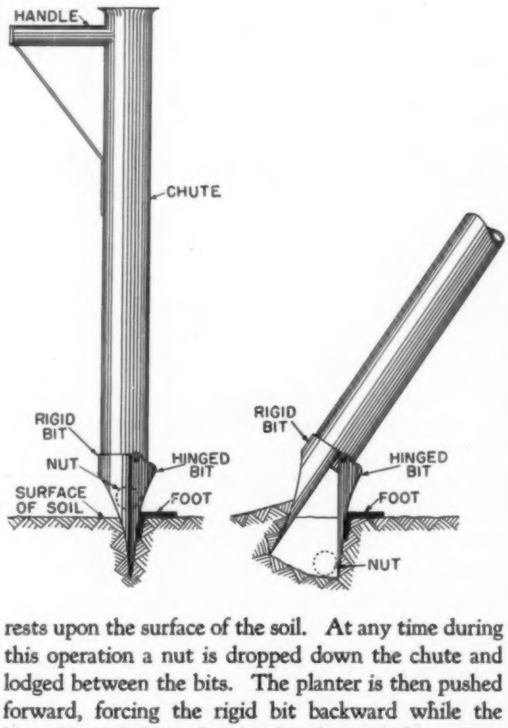
The Soil Conservation Service has announced that 8,500,000 acres of land in 141 land utilization projects established since 1933 will be opened for free public use for hunting, fishing, and trapping. All recreational facilities will be governed by existing State and Federal laws with regard to hunting, fishing, and trapping.

SOIL CONSERVATION IN SCHOOLS

The October issue of Soil Conservation will report classroom activities and educational projects pertaining to soil conservation.

THE POTATO PLANTER ADAPTED FOR SEED-SPOTTING FOREST TREES

By H. D. PETHERAM [1]



TO REMEDY depth variation in seed-spotting walnut, hickory and similar species, the old-fashioned hand potato planter was used very advantageously in 1934 and 1935 during C. C. C. camp operations under the United States Forest Service in Cherokee County, Kans. The plantings were made on waste land that was the result of coal mining by the stripping method.

Planting operations were begun by the shovel method, employing a three-man crew composed of two shovelmen and one dropper. The shovelmen, each equipped with a long-handled round-pointed shovel, removed one shovelful of soil from the spot where the nut was to be planted. The dropper was equipped with a bag containing a supply of nuts suspended from his shoulder. Stationed midway between the two shovelmen, his function was to drop a nut in the hole made by each shovelman. The shovelman then replaced the soil and packed it by stepping on it in passing to the next spot. Depth of planting by this method varied from 1 to 6 inches and close supervision could not eliminate this variation because the shovelmen had no gauge for depth. It was apparent that a more accurate method was needed and thus the hand potato planter was introduced into the seed-spotting operations in the fall of 1934.

The potato planter should not be confused with the hand corn planter. The main part of the implement is a chute which might be made of a piece of eave conductor pipe about 3 inches in diameter and 2½ feet long. A handle is attached and braced to the upper end. On the lower end are two bits, one rigid and the other hinged. To the hinged bit is attached a foot that can be adjusted to any desired depth of planting. A step is also attached to the lower end of the chute for forcing the bits into the soil. (Planters of this type are available at wholesale dealers.)

The operator is also equipped with a canvas bag suspended from the shoulder by a strap. This bag will hold enough walnuts for one hour's planting.

The planter, when in operation, is controlled and carried by the handle. With the planter in a vertical position and the hinged bit to the front, the bits are forced into the soil until the foot on the hinged bit rests upon the surface of the soil. At any time during this operation a nut is dropped down the chute and lodged between the bits. The planter is then pushed forward, forcing the rigid bit backward while the hinged bit is held in place by the adjustable foot. This opens the hole and allows the nut to drop. While the planter is still in this position it is lifted out of the hole, premitting the loosened soil to fall back upon the nut. The operator then steps on the loose soil to pack it. After a little practice he will find that all operations are easy and natural, with continuous movement forward and all back bending eliminated.

The potato planter method has two distinct advantages over the shovel method. In the first place, a uniform depth is obtained by adjusting the foot to the desired depth. A test of depth of planting showed that a 2- or 3-inch covering is most successful; shallower planting apparently results in an uneven supply of moisture while with deeper planting only the most vigorous seedlings are able to reach the surface. It is probable that this depth will vary with different soil types, the sandier soils requiring deeper planting.

The second advantage is that cost of planting is reduced. Actual test showed that one man equipped

[1] Regional division of forestry, Southern Great Plains Region, Soil Conservation Service, Amarillo, Tex.

with a potato planter can plant more nuts than the three-man crew using shovels. The "stop-and-go" system is replaced by continuous and natural forward movement, there is less weight of equipment, and all the work is coordinated in a single operator.

SIZE OF FARM

(*Continued from p. 73*)

and expediency. However, governmental subsidies in the form of work relief and benefit payments and other distress signals such as unpaid taxes and debts overdue, oftentimes may be due not only to an unfavorable price situation but also to the fact that farms may have been organized on a temporary and unstable basis. The effect of some forms of subsidy is merely to perpetuate the need for subsidy. Other kinds of aid to farmers, of a type to enable them to obtain more desirable land use and improve the productive capacity of the land through the establishment of improved practices, may answer not only current financial needs but help to bring about more desirable long-time farm organization. Every effort should be made to increase the proportion of the latter and decrease the proportion of the former kind of assistance to farmers.

Where the present organization of farms cannot be continued without considerable subsidy or acute distress and subminimum standards of living, the most important factors causing such a situation should be given greatest consideration. If an increase in the size of unit is more important than, or necessary to bring about, changes in cropping practices that promise to maintain resources and long-time production, it is of little avail to make the lesser plans which are almost sure to fail because of lack of consideration of more important items.

Minimum income cannot be expressed as a dollar figure equally useful in all areas because of the wide variation in alternative opportunities for employment between specific groups of farmers and between specific areas. Differences in living costs as affected by availability of fuel, the possibility of home gardens and variations in transportation costs, account for variations in the specific dollar figure even under a uniform defininition of minimum income. Loosely defined differences in standard of living constitute another reason for variation in the somewhat arbitrary figures chosen in different areas. For the present purpose, minimum income for a specific locality may be defined as that which is adequate to meet minimum standards of health, education, and individual and community well-being.

While the ramifications of the size of farm problem extend beyond the policy of the Soil Conservation Service into our general agricultural and industrial policies for the Nation as a whole, it is a problem that deserves recognition at all policy levels. This problem might be called one of unemployment or ineffective employment on farms closely related to industrial unemployment in cities. While the full solution of the small farm problem may not be found until some way is devised to utilize effectively our other labor resources, recognition of its incidence on soil conservation may be helpful in determining intermediate courses of action that will alleviate rather than aggravate undesirable situations.

JOHNSON GRASS

(*Continued from p. 70*)

On farms where Sudan is grown for seed there is some danger that it will become contaminated with Johnson grass if the two are grown in the same field. Otherwise, as previously explained, there is small chance of contamination. It is important, too, that the area under discussion furnishes only an insignificant part of the Sudan seed used throughout the Southern Great Plains. The successful growth and use of Johnson grass plantings depend upon the skill and efficiency of the individual operator in: (1) Seeding and growing of the grass, and (2) managing his livestock grazing enterprise so as to obtain the maximum economic returns consistent with safe use of the land- and wind-erosion control.

While Johnson grass is not a cure-all for the grazing problems of this area, it does have the advantage over Sudan and other sorghums in that, once started, it will spring from the rootstocks every year regardless of the fact that much soil has drifted or lodged on the field. Drifting soil will not kill out young root-sprung grass. If there is sufficient moisture in the ground, the grass will come up through 6 to 24 inches and furnish a good binder to hold the soil. On the whole, it would seem that in limited areas in this region Johnson grass may furnish the answer to the quest for a plant that is relatively easy to grow and maintain, that will hold the soil well and will furnish satisfactory annual economic returns.

Controlled studies of the growth habits and other factors peculiar to Johnson grass are now under way.

The Making of "A Heritage We Guard"

By WILLIAM R. VAN DERSAL [1]

SIXTEEN months ago we began work on a new Soil Conservation Service motion picture about wildlife and soil. It is soon to be released under the title "A Heritage We Guard." [2] Between the time the scenario was started and the day the final touches were given the completed film is a story to confound anyone who thinks that movie-making is a simple matter.

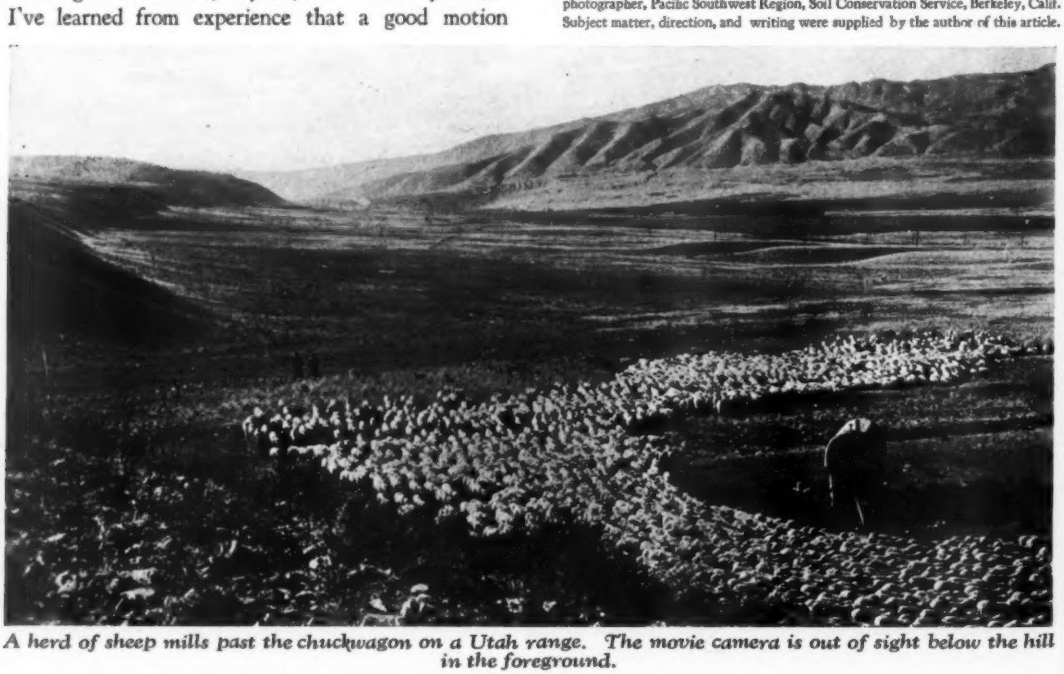
One of the gulls that open the picture.

I thought that once, myself, but not any more. I've learned from experience that a good motion picture like any other creation is about 1 percent idea and 99 percent hard work.

The labor that went into the making of "A Heritage We Guard" began with the preparation of a scenario. The writing went slowly at first, ideas at this stage being nebulous and disconnected. The first scenario did not take long to complete; perhaps that is why it had to be discarded. The second was written with an entirely different approach, but it too was unsatisfactory. Finally emerged a third scenario which told a simple story of American land as people found it, as they used it, and as they must manage it if it is to be preserved. The final title, "A Heritage We Guard" conveys pretty well the underlying theme.

[1] Biologist, biology division, Soil Conservation Service, Washington, D. C.

[2] The director and editor of the new film is Maurice H. Joyce, formerly of the division of information, Soil Conservation Service, and now a director of training films with the U. S. Army; the principal cameraman is Rodney Radford, regional photographer, Pacific Southwest Region, Soil Conservation Service, Berkeley, Calif. Subject matter, direction, and writing were supplied by the author of this article.



A herd of sheep mills past the chuckwagon on a Utah range. The movie camera is out of sight below the hill in the foreground.

Sunlight is reflected on the face of a woodchopper with a silvered plyboard.

From the scenario was assembled a shooting sequence which grouped together the scenes to be made in any one locale. All the supplies were assembled—film, cameras (more than one because many scenes must be shot from several angles simultaneously), batteries to supply power for the motor-driven camera, reflectors to get sunlight into heavy shadows, lights for interior work, long and short tripods, and a host of other miscellaneous materials required for a picture-making field trip. On a soggy day in September, the company finally set forth.

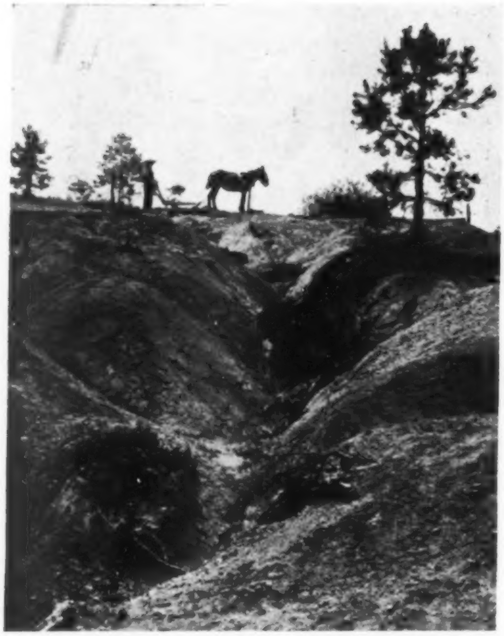
Now that the necessary thousands of feet of film are "in the can," the camera break-downs, the bad weather, the shipment troubles, the failing light, the delays, the uncertain human and animal subjects, all the other things that can—and always do—go wrong during the filming of a picture, seem unimportant. But at the time they took the "glamour" out of movie-making, just as the director knew and said they would.

The Wilderness Material

"A Heritage We Guard" opens with scenes of the country as it looked when settlement first began. Anyone at all familiar with present-day conditions knows that photographing original forest in the eastern United States is now almost impossible since most of it is gone. For "long shots" with panoramas showing a vast extent of forested country, the best that could be done was to show scenes in North and South Carolina made from a vantage point looking toward the Great Smokies. All the rolling hills had long since been lumbered over, but from a distance this is not apparent now. Close shots of forest interior were more difficult; small bits of forest known to have been undisturbed had to be located and the shots made there and nowhere else. Such places are usually remote, as the company soon found.

Areas of virgin grassland—large quantities of it—are nearly as rare as original eastern forest. However, in northeastern Nebraska near the proposed Grassland

Wallace Moilien fished in clear Coon Creek, now fully protected by willows planted six years ago by the Service.



Still plowing while gullies eat farther and farther into his field, this farmer posed for the camera on the skyline.

Monument, there is a piece of prairie that is relatively, but not entirely, undisturbed where there were not so many fence posts and telegraph poles but that the camera could get a sweeping panoramic view without including these ubiquitous signs of civilization. The great herds of buffalo and antelope that were once so much a part of the plains region are now gone. The photography had to be done on Federal or State game refuges. The picture shows the best that could be found, but the numbers are woefully short, even though the effect of special camera angles is to augment the impression received by the audience. Buffalo, by the way, are by no means easy to direct, and there was one time when the future of the Service personnel involved was, to say the least, uncertain.

Other wilderness denizens presented special problems; some were impossible to "shoot." Passenger pigeons have been exterminated; there could be no picture of them. California grizzlies are extinct too, but the Kodiak grizzlies can be distinguished only by an expert mammalogist; so Kodiak bears were used instead, from the film library of the Biological Survey. Waterfowl are now decimated, but even so, great numbers still concentrate on refuges where they can be photographed. Most Indian scenes came from Hollywood studios. One Indian was filmed by Service cameramen near Pendleton, Oreg., for a special scene. For $2.50 this particular redskin agreed to remove his mustache, which seems to be some sort of commentary on modern civilization. It also sets, perhaps for the first time, a standard price for mustache-removal.

Early Days

Photographing historical scenes is not so simple as Hollywood makes it seem in the spectacular pageants that show almost weekly at the local theaters. Scenes historically correct require extensive research. As they were taken for "A Heritage We Guard," the scenes of early settlement were obtained in remote rural districts where dress and ways of doing things have not developed much beyond pioneer days. It is still possible to find houses just as they were made in earliest times, occupied by people whose lives follow a pattern much like that of early settlers. Wild game supplies a part of their food, just as it did when the country was new. Their plows are simple hand-wrought pieces of iron with a small sapling for a handle. Oxen, yoke and all, pull the crude implement in rough, partially cleared land. By paying attention to details such as "store haircuts," or anything else that is "new," the pioneer days can be reproduced in numbers of places in this country.

Portrayal of early days in the plains was not so simple. Covered wagons are still used, but they are not easy to locate, and when found they usually need repair. Early types of steam trains called for by the scenario, if they have not long since rusted to pieces are to be found now mostly in museums. In such dilemmas the Hollywood studios helped enormously by providing sufficient material from their libraries.

Early cattle of the true long-horned type have been replaced by superior breeds. But the scenario called for longhorns, and fortunately there is one small herd left, laboriously assembled some years ago by the Forest Service and now preserved on the Wichita Refuge in Oklahoma. These animals are a real curiosity, exciting as much interest at the refuge as buffalo or antelope. And in Oklahoma the historically accurate longhorns milled about obligingly while the cameras recorded them from all angles.

Sheep and examples of overgrazed range were shot in the Southwest with the help of amiable and mildly interested sheepherders. A flock of several thousand, complete with herders, dogs, and chuckwagon provided material for many fine scenes. After the almost incredible numbers of sheep had passed by, a few shots to show the condition of the overstocked range provided an all-too-clear illustration of land abuse.

Longhorn cattle on the Wichita Refuge in Oklahoma.

Good localities for photographing erosion and its effects were not difficult to find. There was little need to put them in the shooting schedule. Erosion was filmed as opportunity, i. e., good light and time, permitted, because eroded land was revealed almost at every turn in the road. The biggest problem was to avoid shooting too much, thereby seeming to emphasize the severity of the erosion problem—if, indeed, that can really be done. Certain it is that the finished motion picture did not need to dwell on any one part of the country. There was plenty of material from every section and it included everything from gaping gullies filled with the inevitable automobile parts to worn-out fields and wretched and dilapidated farm buildings on land long since in the submarginal class.

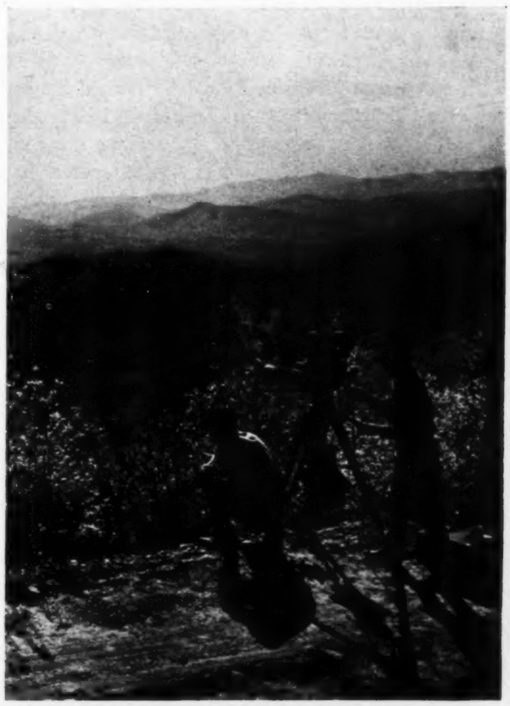
Rain and washing soil were photographed down South one rainy day. Beginning with black clouds and running through spattering raindrops on bare soil to rivulets of muddy water, and finally to swollen, muddy streams, the scenes tell quickly and simply the now-familiar story of wasteful farming.

Abundant wildlife is an accompaniment of sound land use. Like soil, wildlife depends for its survival on good cover. Unlike soil, however, animals are photographically extremely interesting, and they enliven many scenes in which it would otherwise be difficult to hold or awaken interest.

In "A Heritage We Guard" wildlife is shown to be a part of the heritage, and numerous close-ups of birds and mammals are used. Fortunately for the Service, Dr. Arthur A. Allen, of Cornell University, nationally famous for his bird films, had on hand a large amount of film and sound of farm birds. His pictures have been made at considerable expense and over many years. From his library much excellent material was found to be adaptable.

The wild mammals—squirrels, raccoons, foxes, rabbits—were more difficult. They are extremely fearful of man and consequently hard to film. The Service photographer was lucky with a few animals. While shooting the long-horned cattle, for instance, he managed some very good opportunity shots of a rabbit. Some close-ups had to be made at the Washington Zoo, to the profound discomfiture of the camera crew as well as the animals. Strong lights were necessary, and strong lights are notorious for driving animals into hiding.

It has been said truly that a picture is made in the cutting room, and so it was with "A Heritage We Guard." All the scenes were at last assembled, the obviously poor ones discarded, the several takes of each scene examined for the best, and the selected material spliced to make the first cut. In spite of the greatest care in the field, some scenes did not match those with which they were cut, and there was much shifting and fitting and paring until the continuity was achieved. Dissolves, fades, wipes, montages, superimposes—the simple tricks of making a film easier to follow were calculated and manufactured in the laboratory. Once in final shape the proper music was put on its sound track, the special sound effects on another sound track, the commentation added—three sound tracks synchronized with the scenes, every sound matching action on the screen.



The cameraman and director shoot a panorama of "virgin" forest in the Carolina hills.

KIKUYU GRASS

Kikuyu controlling a once-acute gully on the W. A. Hardison farm, Las Posas project.

KIKUYU (*Pennisetum clandestinum*)—a grass which was once considered objectionable in California because of its resistance to control and eradication—is now being requested for use in erosion-control activities by many farmers in the Pacific Southwest Region.

Kikuyu is a native of Uganda, Africa. It is now widely distributed throughout New Zealand, Australia, and South Africa.

Kikuyu was introduced into the United States by the United States Department of Agriculture in 1915, and was first tested at various sites in California in 1916. Because it was thought to be difficult to control and eradicate, plantings of the grass were restricted for observational purposes. These observational plantings have shown Kikuyu to be well adapted to southern California conditions. It has successfully withstood temperatures as low as 23° F.

Kikuyu is a strong, creeping perennial grass. The grass forms a dense turf, with branching leafy stems; its leaves are flat and spreading. In areas of limited rainfall, it will make little top growth, although it sends out shoots and spreads along the ground, establishing itself firmly. In the presence of moisture, however, it has been known to grow as high as 2½ to 3 feet. It grows well on moist soils, and it responds vigorously on good soils. It has not been known to yield seed in California and can be established only by roots or runners. It is very aggressive and resists other plants growing with it. Weed invasion, therefore, is avoided. The initial cost of establishing Kikuyu is slightly higher than that of seed-bearing grasses, but this is compensated for by the fact that once it is established, it will take care of itself and needs no replanting.

Kikuyu is essentially a pasture grass. As a forage crop, it is known to be as luscious, palatable, and nutritious as Bermuda.

Kikuyu has great possibilities as a soil binder for dam embankments, eroding slopes and gullies, and for revegetation purposes. Some excellent grassed waterways, on which Kikuyu is used, have been developed in California; some of them are on very steep slopes. A farmer in South Africa has completely reclaimed a gully on his farm with Kikuyu. The gully, cutting across his land 15 feet deep in some places, was draining the soil of all its scanty moisture (the rainfall in the area is approximately 10 inches). He began his experiment of gully reclamation with Kikuyu in 1922. Today, the gully is entirely healed and is furnishing a pasture of unexcelled quality. A detailed discussion of this experiment appeared in the February 1940 issue of "Farming in South Africa."

If it is desired to control or eradicate the grass, this can be done by plowing and subsequent cultivation to expose the underground parts of the plants to the sun or frost. A visitor from Australia recently remarked that he was surprised that California farmers are afraid of the grass, because it is one of the best species grown in Australia and very little trouble is required to control it.—Lenora E. Eastwood.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

THE PLOUGH-UP POLICY AND LEY FARMING. By Sir George Stapledon. London, 1939.

This is a down-to-earth book, urgent and at the same time eminently practical. Over a year ago Great Britain offered to pay her farmers to plow the "green swards" of Old England and start an intensive emergency program to improve fertility of the soils. It was fortunate for British farmers that Dr. Stapledon was in a position to produce so quickly this book on the new policy; otherwise the program might not have gone forward with such speed to meet so effectively the present food-crop and livestock-forage emergency. The volume is reviewed here to point out the details of Britain's plan to conserve her stale and derelict grasslands by a rotation farming scheme that may well be adaptable to many parts of the United States. Certainly, we have already learned much from England and Wales about maintaining fertility, and now Dr. Stapledon causes us to think deeply about grassland management and soil fertility in connection with our own program to extend our grass acreage. Sir George Stapledon has world-wide recognition for his work as director of the Welsh Plant Breeding Station, the Cahn Hill Improvement Scheme, and the Imperial Bureau of Pastures and Forage Crops, Aberystwyth, Wales. According to the latest issue (June 1940) of Herbage Reviews, he is also to be in charge of the new project to establish demonstrations on 600 acres of poor-condition heavy clay land near Stratford-on-Avon to show details and effectiveness of (1) improvement as permanent grass by various methods short of plowing, (2) farming by rotating temporary grass with arable crops and, (3) plowing and immediate reseeding.

Fertility is not produced merely by plowing in the sod—this is emphasized. A poor sward is a pasture deficient in phosphates and nitrogen, a pasture with an impoverished or pot-bound sod with the wrong assemblage of grasses and plants—this is pointed out so simply and with such downrightness that no farmer can mistake his poor pasture for a good pasture. Directions for plowing, applying fertilizers to rot down the old sod, for planting and handling catch crops, for grazing without waste of forage and for proper manuring, and for harvesting throughout rotations are so definite and authoritative that they can be used, and no doubt are, by British farmers as field rules to be followed to the letter.

In view of the emergency in Britain, Dr. Stapledon offers grassland farmers two alternatives, and before choosing they must first know the soils underneath their sod and the sward topping the soils. Are they the better soils or the poorer? Are the swards derelict or good or merely fair? Farmers of Britain are told how to deal with any and every British pasture—how to plow to kill old turf in preparing for an autumn cereal or spring crop or a mixture on better soils; how to manure the poorest pastures by intensive grazing before plowing and preparing tilth for a pioneer crop; how to turn permanent pastures into cropable land for a 10-year emergency period.

Throughout, several points—they cannot be called theories because Dr. Stapledon does not theorize—several points stand out as particularly pertinent to the United States grassland programs. The first is, of course, the fact that the poorest soils are being restored quickly by means of frequent plowing and cropping combined with heavy grazing of the "on-and-off" type for the specific purpose of complete plant nutrient turnover. Second, the indigenous varieties and strains of grasses and clovers used in grassland rotation farming in England and Wales are interesting from the point of view of needs for hay and grazing needs. In England and Wales, most experiments have dealt chiefly with pasture strains and farmers have been disappointed in first- and second-year hay crops from the pasture plants. Dr. Stapledon attempts to meet this difficulty with a plan to include pasture strains in small amounts for 3 years in order to produce more leafy hay, increase both pasture and hay yields, and to provide a longer effective grazing season.

Many rotations are recommended, all of them based on trial and the author's broad experience and knowledge. One of them is particularly interesting in that it is designed to restore the poorest soil quickly with use of artificial fertilizers. Briefly, it consists of (1) ribgrass, (2) hardy green turnips and Yorkshire fog, (3) hardy green turnips and Italian ryegrass, (4) hardy green turnips, rape and Italian ryegrass, (5) rape and Italian ryegrass, (6) rape and Italian ryegrass with 1 pound of hardy green turnips. Such a rotation calls to mind some of the industry-devastated areas of the United States, or pastures grown to weeds that might be plowed up and prepared for potatoes, kale or seed mixtures for grazing.

One chapter suggesting that herbs may supply needed minerals to livestock is interesting especially from the point of view of research. Apparently little had been done along this line at the time Dr. Stapledon wrote "The Plough-up Policy and Ley Farming." It had been noticed, however, that stock turned on "super" swards tended to graze hard around edges of pastures and a group at Aberystwyth had started experimenting with strips of herbs sown with slow-maturing grass in leys. Results of these experiments will be most interesting when they are forthcoming.

Seed mixtures for catchcrops, for 12- to 18-month swards with catchcrops, for 2-, 3-, and 4-year and longer leys are set down with appropriate proportions per acre for all-grazing, all-hay, and grazing and hay pastures of different durations. Permanent pastures are not treated in detail, as the purpose of the book is to advocate plowing up of poor permanent pastures.

The chapter on grass and clover seed production is written by Mr. Gwilym Evans, one of Dr. Stapledon's associates in Aberystwyth. It turns out to be an exceedingly direct and well-organized account of methods used by farmers who grow seed for the Welsh Plant Breeding Station. Mr. Evans first points out climatic and soil conditions and situation required for best seed growing in England and Wales. Highlights of technique may be briefly outlined as follows: Green crops are generally the best preparatory crops for production of herbage plant seeds, although fertile land if manured will grow ryegrass and clover seed after two crops of corn. Grass and clover for seed should be isolated 200 to 400 yards from each other. Grasses may be broadcast or placed in drills; clovers may be broadcast in corn. Cultivation, manuring, weeding and grazing of seed-producing pasture plants constitute an intensive type of farming requiring constant care and labor and observation, nor does vigilance decrease in judging ripeness, harvesting and drying the seed. After ryegrass seed crops broadcast with

white clover, corn may be grown. Straw of seed crops is used for fodder.

It must be remembered that Dr. Stapledon writes of the pastures of Britain; but, even so, grassland rotations are none the less important in our own regrassing program for soil conservation and fertility. In the book reviewed here the chapter on management of the ley is peculiarly important in that it points out urgently what not to do, what to do and how, for lush sward, for soil fertility and for a type of rotation that is safe, practical and productive of high quality crops in England and Wales.

While I was talking over Dr. Stapledon's book with C. R. Enlow, chief of the Division of Agronomy of the Soil Conservation Service, Mr. Enlow made the following remarks clarifying differences between Britain's plow-up policy and America's more-grass policy:

"Dr. Stapledon presents a philosophy that is essential in a grassland agriculture, a type of farming that is being promoted at the present time in this country. The importance of bringing sod crops into the rotation for the improvement of our soils cannot be overstressed. But it must be understood that to get an increase in organic matter and improvement in soil structure we must use desirable grasses and legumes and not worthless ones. To do this, we must expect to apply minerals in sufficient quantity to overcome soil deficiencies and encourage the growth of desirable sod crops; and we must manage properly the sod crops as hay or pasture to secure profitable returns plus soil improvement.

"In the program for soil conservation in the United States, a very large acreage of infertile cropland is being retired to so-called 'permanent' pasture and meadow. This land should give us great concern as we cannot expect it to produce good pasture or hay if it will not produce good crops. Without soil-building practices, we may be overstating in declaring it safe from erosion.

"We already have many millions of acres of 'permanent' pasture that are practically worthless in their present condition because of soil impoverishment, overstocking, or both; and the land is actually deteriorating. Bringing sod crops into the rotation with cultivated crops for hay and grazing would tend to relieve this land and also would improve the cropland.

"To the traveler in England, it appears that the entire countryside is in grass, while the reverse is true in the United States. We need more grass at the moment, England needs less. The ultimate objective, permanent agriculture, is the same."

Britain's emergency fertility program is requiring plowing and more plowing, and it may be unfortunate for our own grassland program if we do not plow enough. In this connection the following statement made by Dr. P. V. Cardon, an authority on pasture in the United States, is quoted from O. E. Baker's review of "The Plough-up Policy and Ley Farming" which appeared in the April 1940 issue of the Geographical Review:

"Two things, implied in the title, are significant: First, the 'plough-up policy' is, in a sense, a reversal of policy. Britain is a grass country, and, traditionally, we Americans think of Britain as a good example of what countries wedded to the grass-land philosophy may accomplish. Yet, despite her earlier trend, Britain today is plowing up grass, paying farmers to do it, under a national policy not born of, though accelerated by, war. The primary purpose of the 'plough-up policy' is to conserve soil fertility. This strikes me as significant. Whereas we in America are urging gras planting as a means of soil conservation, Britain now turns to grass breaking for the same purpose.

"This is not difficult to understand, if one is aware of the second point I would stress as coming out of Dr. Stapleton's book, namely that grassland itself grows stale. The solution is 'ley farming.' We call it 'rotation farming.' This is important. I have long felt that merely to extend our grass acreage will fall short of solving our more basic problem, soil conservation. We must find the place of grass in farm practice and utilize grass with other crops, in a general scheme of rotation or ley farming. * * * The pattern, as I see it, is grassland agriculture, conceived on a rotation basis—a rotation of crops, including grass, where crop rotation is feasible, and rotation grazing of a high type on our range lands."

REVIEW AND DISCUSSION OF LITERATURE PERTINENT TO CROP ROTATIONS FOR ERODIBLE SOILS. By C. R. Enlow. U. S. Government Printing Office, Washington, D. C. Manuscript completed July 1939, published June 1940.

This new bulletin points out the serious dearth of published material having to do with suitable crop rotations for tremendous areas in the United States that are subject to wind and water erosion. The urgent need for experimental work, more planning, and better coordination of rotation methods and sequences for the purpose of fertility increase cannot be ignored for long if the organic matter content of the soils of many areas is to be maintained. Judging from Mr. Enlow's review of the available literature on the subject, most rotations used in the United States have been designed specifically to increase yield and income, and many have failed to maintain and improve fertility conditions. He emphasizes the fact that it is very difficult to develop rotation sequences for many regions and areas of so large a country from a study of the available literature.

The discussion of the writings of upwards of two hundred authors shows that there has been considerable confusion of objective in the attempt to establish cropping practices that will meet production requirements and at the same time improve soil conditions and control erosion. Such confusion is clarified greatly by this type of study.

The review of the available material is based on known soil organic-matter losses for various parts of the country and rotations that have been tried out in attempts to determine the places of soil-improving crops in different rotation sequences. Findings at soil and water conservation experiment stations and Federal and State experiment stations are arranged regionally to point out the wide variations of cropping required for the soils of the great soil groups as distributed throughout the United States.

A complete bibliography of the authors and works reviewed is given at the end of the bulletin. This, with Mr. Enlow's discussions of the problems from the point of view of the agronomist whose duty it is to develop rotation programs for recommendation to farmers, should make this study of the literature of real value to agronomic planners and especially to experimental workers attempting to establish data to support crop rotation recommendations.

U. S. GOVERNMENT PRINTING OFFICE: 1940

During the past 2 years the Educational Service of the State Department of Conservation has made available to Tennessee schools 103,000 seedlings for use in connection with conservation problems. (Photograph by courtesy of Tennessee Department of Conservation.)

Editor's Note.—Soil conservation is a subject of widespread interest to students and teachers alike. This issue of the magazine offers a small selection from many available reports. It makes no pretense at complete coverage or adequate representation.

A representative of the Educational Service of the Tennessee Department of Conservation discusses with fifth-grade boys and girls the effect of uncontrolled run-off on agricultural land unprotected by winter cover crops. (Photograph by courtesy of Tennessee Department of Conservation.)